OFFICE OF THE UNDER SECRETARY OF DEFENSE

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WASHINGTON DC 20301-3000

ACQUISITION AND
TECHNOLOGY

June 11, 2002

MEMORANDUM FOR U.S. MISSION TO NATO, ARMAMENTS COOPERATION DIVISION
(ARMY ARMAMENTS OFFICER), PSC 81, APO AE 09724

SUBJECT: Draft STANAG 4488 (EDITION 1) – "EXPLOSIVES, SHOCK SENSITIVITY TESTS"

Reference document, AC/310-D/189, 7 September 2001, SAB.

The U.S. Armed Forces ratifies the referenced agreement with comment.

Ratification and implementation details are as follows:

	IMPLEMENTATION					
	Forecast Date			Actual Date		
RATIFICATION REFERENCE	NAVY	ARMY	AIR FORCE	NAVY	ARMY	AIR FORCE
Memo, OUSD(A&T) DATED AS ABOVE		June 11, 2002			June 11, 2002	

NATIONAL IMPLEMENTING DOCUMENT: MIL-STD 1751.

RESERVATIONS: None

COMMENTS: See attached DA Form 4797-R.

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Anthony J. Melita

1 Encl. as

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Comments to STANAG 4488E2

NO (a)	NATION (b)	PAGE (c)	PARA (d)	LINE (e)	COMMENT(S) (f)	REASON(S) (g)
1	U.S.	C-1	1	3	**COMMENT:** It is suggested that the 76mm be changed to 73.2mm.	The critical diameter of the acceptor explosive should be less that the ID of the test hardware
2	U.S.	D-1	3	1	**COMMENT:** Either insert a schematic of the tst setup or remove the first sentense of the paragraph	There is no Figure 7 and hence no schematic of the test setup.
3	U.S.			General	**COMMENT:** Plexiglas is a registered trademark in the U.S. The terms ''plexiglass'' (double s at the end) and ''Plexiglas'' (one s) are both used without indication of the trademark. Question - Does this apply in the international arena? If so, need to add trademark.	
4	U.S.			General	**COMMENT:** The U.S. uses two additional shock tests that are not included in this STANAG. These are the NOL Large Scale Gap Test and the NOL Small Scale Gap Test (identified as test methods 1041 and 1042 in MIL-STD 1751. This is not an issue because the STANAG allows data from other tests as long as test results are provided for comparison explosives. However, recommend that SG1 consider these other U.S. tests when this STANAG comes up for review.	

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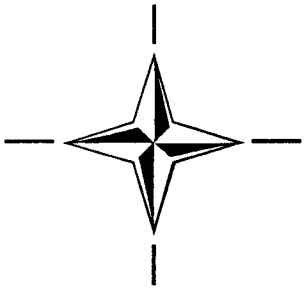
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)



NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: EXPLOSIVES, SHOCK SENSITIVITY TESTS

Promulgated on 12 September 2002

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

STANAG 4488
(Edition 1)

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director, NSA under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/NSA - Bvd Leopold III, 1110 Brussels - BE.

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NAVY/ARMY/AIR

NATO STANDARDISATION AGREEMENT (STANAG)

EXPLOSIVES, SHOCK SENSITIVITY TESTS

Annexes:

A. Small Scale Gap Test
B. Intermediate Scale Gap Test
C. Expanded Large Scale Gap Test
D. Super Large Scale Gap Test

Related Documents: None

AIM

1. The aim of this agreement is to establish test procedures which provide information on the shock sensitivity of explosive materials.

AGREEMENT

2. Participating countries agree to accept these tests as standard procedures for determining the shock sensitivity of explosive materials, and to use the data exchange formats as provided in the annexes. For the determination of the shock sensitivity of an explosive for Qualification, only one test is required from the four annexes.

3. The appropriate test to be used is determined by the confined critical diameter of the test explosive. The critical diameter of the test explosive should be less than the diameter of the acceptor test body. In cases where the approximate shock sensitivity characteristics of the acceptor are unknown, the first sensitivity test should be performed at zero gap (i.e. no attenuator used). If no detonation occurs, one of the larger size gap tests should be performed.

IMPLEMENTATION OF THE AGREEMENT

4. This STANAG is considered implemented by a nation when that nation has issued the necessary orders/instructions putting the contents of this agreement into effect.

ANNEX A to
STANAG 4488
(Edition 1)

SMALL SCALE GAP TEST

Scope

1. This method covers the test procedures to be used for the determination of the small-scale shock sensitivity of explosive materials. This technique is primarily designed to be used for booster and main charge explosives with critical diameters less than 20 mm. Data from other small scale tests are acceptable for Qualification as long as the test results are provided on a comparison explosive as defined in STANAG 4170 and a calibration curve of input pressure vs. attenuator thickness is available.

Principle

2. Like other gap tests, this test is a measure of the shock required to initiate and propagate a high order detonation in the explosive being tested. The sensitivity of the acceptor explosive is determined as a function of the height of a water column which is used to attenuate the shock output of the donor explosive. Results are expressed as the height of the water column at which the acceptor is initiated 50% of the time. The corresponding pressure in the barrier at the barrier/acceptor interface may be obtained by referring to the calibration data provided in Table 1.

Apparatus

3. The test setup for the small-scale gap test is described schematically in Figure 1. Plexiglass tubing, dimensions of which are shown in Figure 2, serves as the confining material for the donor charge, acceptor charge, and water attenuator. An electric detonator is used to initiate a donor charge of 95.0% RDX and 5.0% wax which has been pressed to a density of 1.60 ± 0.02 g/cm^3. Dimensions of the donor charge are shown in Figure 3.

4. The acceptor explosive will have finished dimensions of 21 mm diameter by 40 mm length in the plexiglass tube. It is separated from the attenuating water medium by a .013 mm thick polyethylene sheet. Water tightness is ensured via a compression fit between the polyethylene sheet and the plexiglas tube. After combining the two plexiglass tubes, the volume above the acceptor charge is filled with water to the required height. The donor charge, which is held in place through a press fit, is positioned so that its lower end is in contact with the water. Care must be taken to avoid air gaps in the water pocket.

5. The test arrangement is then fastened to a steel bar on the pedestal which supports the test apparatus and ensures that separation does not occur between the plexiglass tubes. One end of a detonating cord is positioned flush on the output side of the acceptor and the other up against a witness plate. A detonator is inserted in the donor and the test is performed. A test is considered to be a "go" if the witness plate has an indentation caused by the detonating cord.

Sample Preparation

6. The donor explosive is inserted directly into the plexiglass tube. The acceptor explosive is either pressed to the required density or cast directly into the plexiglass holder. When preparing these samples, it is critical that the faces of the explosive sample be flush with the ends of the tubes into which they are loaded.

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Types of Reaction

7. A detonating cord and a witness plate (aluminum or lead) are used to indicate whether detonation occurs. Essentially, if the output of the acceptor initiates the detonating cord and results in a dent on the witness plate, a "detonation" is judged to have occurred. Conversely, if the plate is not damaged, a "No detonation" is recorded.

Test Procedure

8. The procedure for determining the sensitivity of a given explosive substance follows a fixed pattern. The first test is performed at an arbitrary water height which is measured using a standard scale. If the substance fails to detonate at that height, the next test is performed at one-half the height of the first test. The procedure is followed until a detonation occurs. Conversely, if the initial test results in a detonation, the subsequent test is run at double the water gap used in the first test.

9. A Bruceton type statistical approach is then conducted with a sample size of 25 shots per test series required. A 50% point in mm of water is then determined for the test sample. Variations in water temperature have not been found to have any significant effect on test results.

Reporting of Results

10. Figure 4 provides the standard data sheet under which all test information should be reported. For comparison purposes with other explosives and/or test methods, the final test result should be reported as the input pressure in kbar at which the 50% point is determined.

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FIGURE 1. SMALL SCALE GAP TEST SETUP

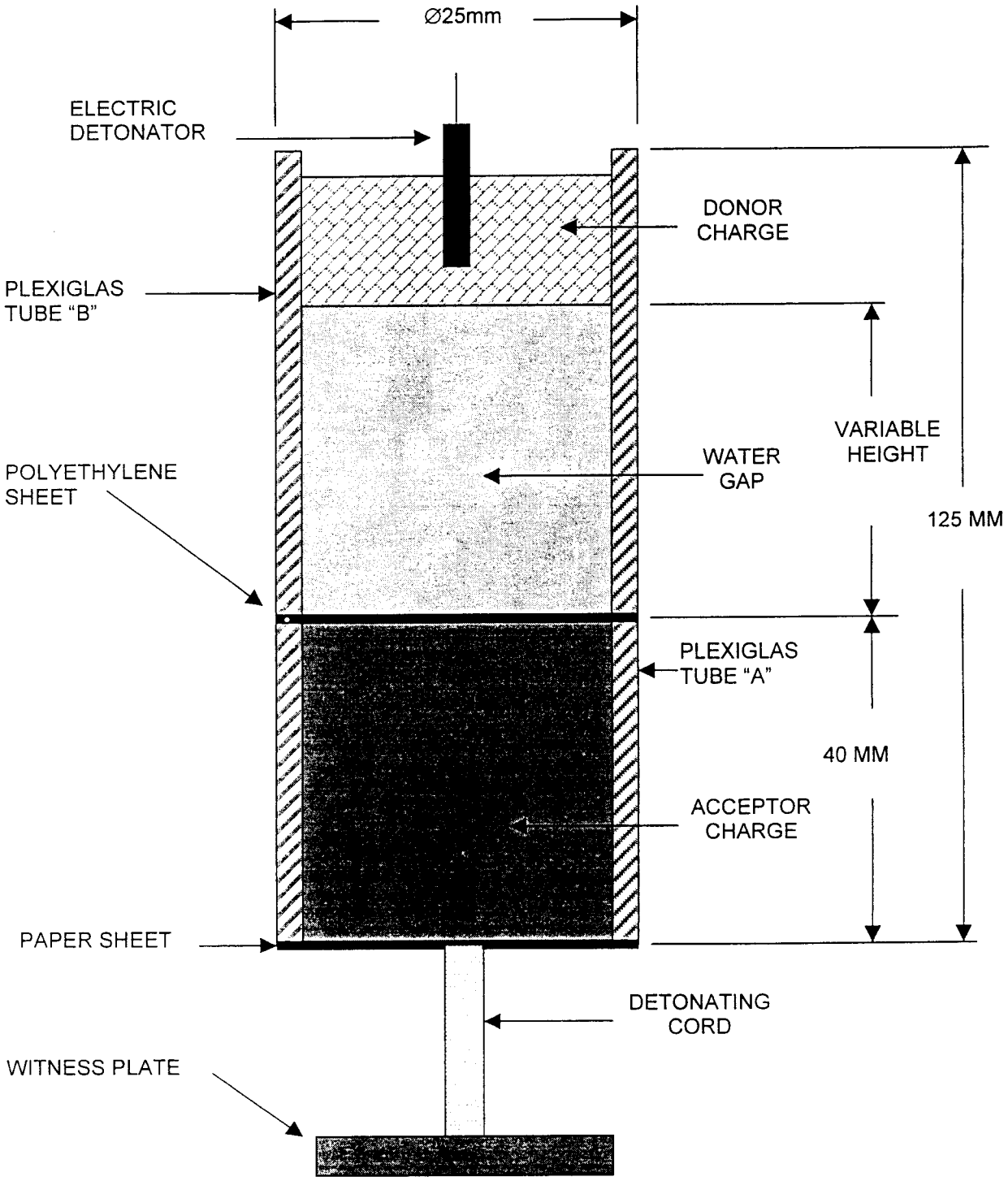

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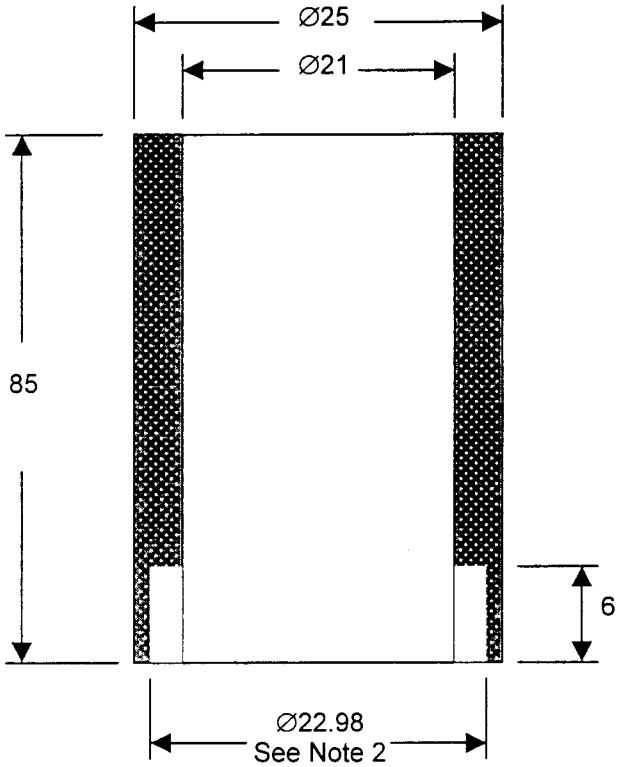
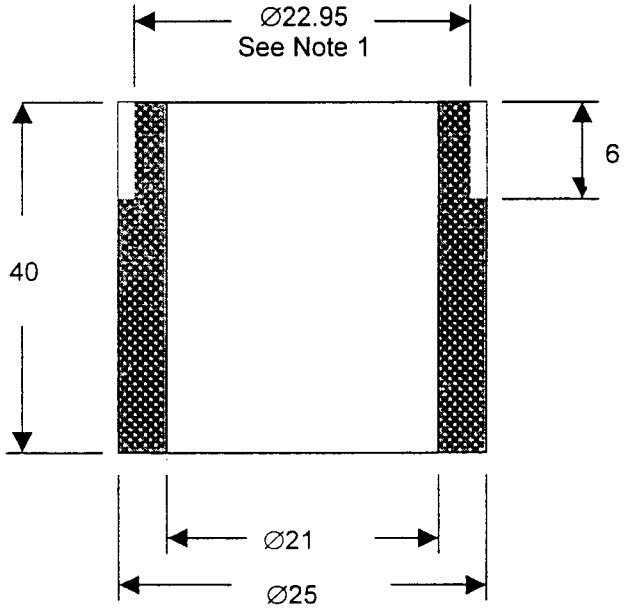
FIGURE 2. SMALL SCALE GAP TEST HARDWARE



TUBE B

Note 2: Indent of 22.98mm extends down only 6mm on the inner diameter of the tube B.

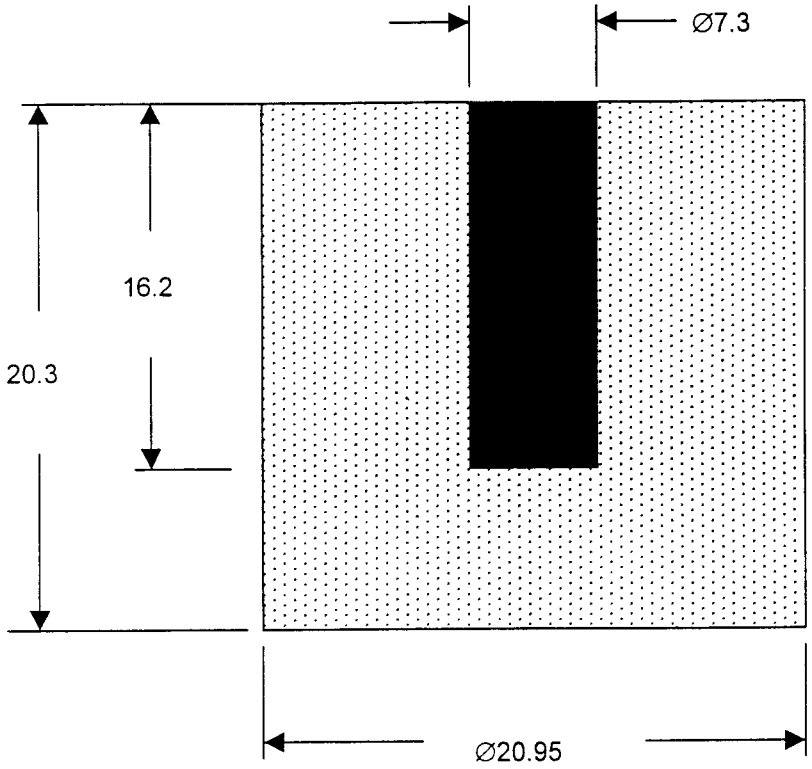


TUBE A

Note 1: 22.95mm outer diameter extends only 6mm down length of Tube A.

All Dimensions in mm.

FIGURE 3. BOOSTER CHARGE



Notes:
1. All dimensions in mm.
2. Explosive charge composition is 95% RDX, 5% Wax.
3. Charge density = 1.60g/cm^3

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FIGURE 4. SHOCK SENSITIVITY TEST – RESULTS DATA SHEET

EXPLOSIVE TESTED: _____

EXPLOSIVE DENSITY/%TMD: _____

SHOCK SENSITIVITY TEST USED: _____

TEST ACTIVITY: _____

TEST DATE: _____

PREPARATION (i.e. CAST, PRESSED): _____

TEST RESULTS (X = DETONATION; O = NO

ATTENUATOR THICKNESS (mm)	PRESSURE INPUT LEVEL (Kbar)	SHOT NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

OF SAMPLES TESTED: _____ REMARKS: _____

MEASURED 50% POINT: _____ (Kbar) _____

TABLE 1. SMALL SCALE WATER GAP TEST CALIBRATION DATA

HEIGHT (mm)*	PRESSURE (kbar)	HEIGHT (mm)*	PRESSURE (kbar)
7.0	49.5	35.0	6.2
8.0	45.8	36.0	5.8
9.0	42.2	37.0	5.4
10.0	38.8	38.0	5.0
11.0	35.7	39.0	4.7
12.0	32.9	40.0	4.4
13.0	30.4	41.0	4.1
14.0	28.1	42.0	3.8
15.0	26.0	43.0	3.5
16.0	24.1	44.0	3.3
17.0	22.4	45.0	3.1
18.0	20.9	46.0	2.9
19.0	19.6	47.0	2.7
20.0	18.4	48.0	2.5
21.0	17.2	49.0	2.4
22.0	16.2	50.0	2.2
23.0	15.2	51.0	2.1
24.0	14.3	52.0	1.9
25.0	13.3	53.0	1.8
26.0	12.4	54.0	1.7
27.0	11.5	55.0	1.6
28.0	10.7	56.0	1.5
29.0	9.9	57.0	1.4
30.0	9.1	58.0	1.3
31.0	8.4	59.0	1.2
32.0	7.8	60.0	1.1
33.0	7.2	61.0	1.0
34.0	6.7	62.0	0.9

*NOTE: Calibration data and test results are not available for water gap heights less than 7.0mm.

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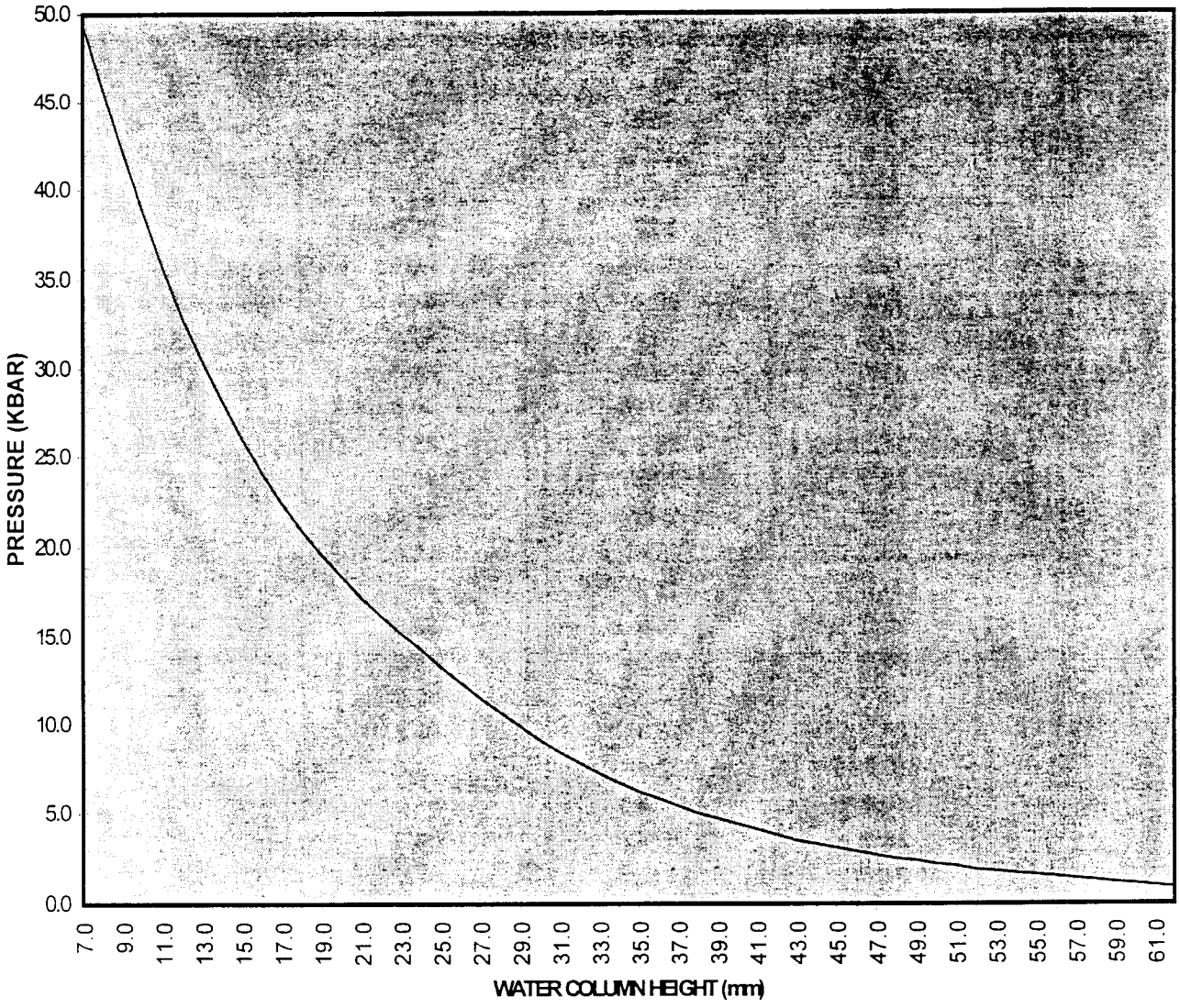
TABLE 1. SMALL SCALE WATER GAP TEST CALIBRATION DATA (CONT.)



ANNEX B to
STANAG 4488
(Edition 1)

INTERMEDIATE SCALE GAP TEST

Scope

1. This method covers the test procedures to be used for the determination of the large scale shock sensitivity of explosive materials. This technique is primarily designed to be used for booster explosives, main charge explosives and propellants with critical diameters greater than 20 mm and less than 40 mm.

2. Data from other intermediate scale tests are acceptable for Qualification as long as the test results are provided for a comparison explosive and a calibration curve of pressure in the barrier at the barrier/acceptor interface vs. attenuator thickness is available.

Principle

3. Like other gap tests, this test is a measure of the shock required to initiate and propagate a high order detonation in the explosive being tested. The sensitivity of the acceptor explosive is determined as a function of the thickness of an inert cellulose acetate barrier which is used to attenuate the shock output of the donor explosive. Results are expressed as the thickness of the attenuator at which the acceptor is initiated 50% of the time. The corresponding pressure in the barrier at the barrier/acceptor interface may be obtained by referring to the calibration data provided in Table 2.

Apparatus

4. Materials required to conduct one test are:

(a) Steel Tube: Cold drawn without welding; inner diameter of 40 mm +0.4/-0.0; thickness of 4 mm, and 200 mm +0/-1 mm length

(b) Cylindrical Cardboard Tube: 42-47 mm in diameter and 85 mm long

(c) Cylindrical Cardboard Tube: 50-55 mm in diameter and 350 mm long

(d) Cylindrical Cardboard Tube: 42-47 mm in diameter and 40 mm long

(e) Cellulose Acetate Cards: Disk form of 46 mm $\pm$ 0.5 diameter and 0.19 +0.02/-0.01 mm thick

(f) Mild Steel Witness Plate: 150 mm x 150 mm x 10 mm thick

(g) Donor Explosive Charges (2): Consisting of 95% RDX/5% Wax (0.5% Graphite is added as a processing aid) at a density of 1.60g/cm^3; each in the form of a cylinder 40 mm in diameter and 40 mm long. One booster has a centered hole 7.3 mm +0.2/-0.1 in diameter and 25 $\pm$ 5 mm deep.

(h) Witness Charge: Consisting of 95% RDX/5% Wax/0.5% Graphite at a density of 1.60 g/cm^3 in the form of a cylinder 40 mm diameter and 40 mm long.

(i) Suspension Cords: 2-3 mm cords with two twisted strands and 4 m long.

(j) Tightening Ring: Made from plastic covered wire.

(k) Detonator: Standard UN/EXTEST, or an equivalent containing 0.6 g of PETN as the base charge.

Sample Preparation

5. The RDX/Wax donor explosive pellets are pressed independently to a density of 1.60 $\pm$0.02 g/cm^3. Test specimens are prepared by either casting the sample directly into the steel tube or by inserting a

cylindrical sample (40.0 mm +0.0/-0.4 diameter by 200 mm +1.0/-0.0 length) into the tube. When preparing these samples, it is critical that the faces of the explosive sample be flush with the ends of the tubes into which they are loaded. All sample explosives must be tested, by X-ray or other equivalent method, to ensure that there are no voids present.

Types of Reaction

6. Interpretation of the witness plate damage is used to decide whether detonation has occurred. A positive result or "go" reaction is recorded when a neat circular hole is punched in the plate and an undamaged plate, broken plate, or one with a poor quality hole is considered a "no go."

Test Procedure

7. In the cardboard tube (c), successively introduce:

(a) witness charge (h) into the cardboard tube (d) with the most dense end placed toward the bottom;

(b) the acceptor charge and steel tube (a);

(c) the number of cellulose acetate cards (e) corresponding to the height selected in the following series: 1, 2, 3, 4, 5, 5n (n = 2 to 80) that is applicable to that specific test, and

(d) the donor charges (g) placed into the cardboard tube (b).

8. The assembly is then placed vertically in the center of the steel plate (f) with the witness charge centered in contact with the steel plate. The various elements of the assembly are held together by the suspension cords (i) and the tightening ring (j). As prepared, the charge is suspended vertically so that the steel plate (f) is more than 20 cm off the ground. The detonator (k) is inserted into the donor charge (g) hole and the shot is fired. Figure 5 provides a schematic of the test setup.

9. Twelve trials are generally used to characterize an explosive. The first test is performed using 200 cards. The number of cards is then increased or decreased based upon the previous test result. A staircase type procedure is then used to approach a 50% point.

Reporting of Results

10. Figure 4 of Annex A provides the standard data sheet under which all test information should be reported. For comparison purposes with other explosives and/or test methods, the final test result should be reported as the thickness of the cellulose acetate cards at which the 50% point is determined.

FIGURE 5. INTERMEDIATE SCALE GAP TEST SETUP

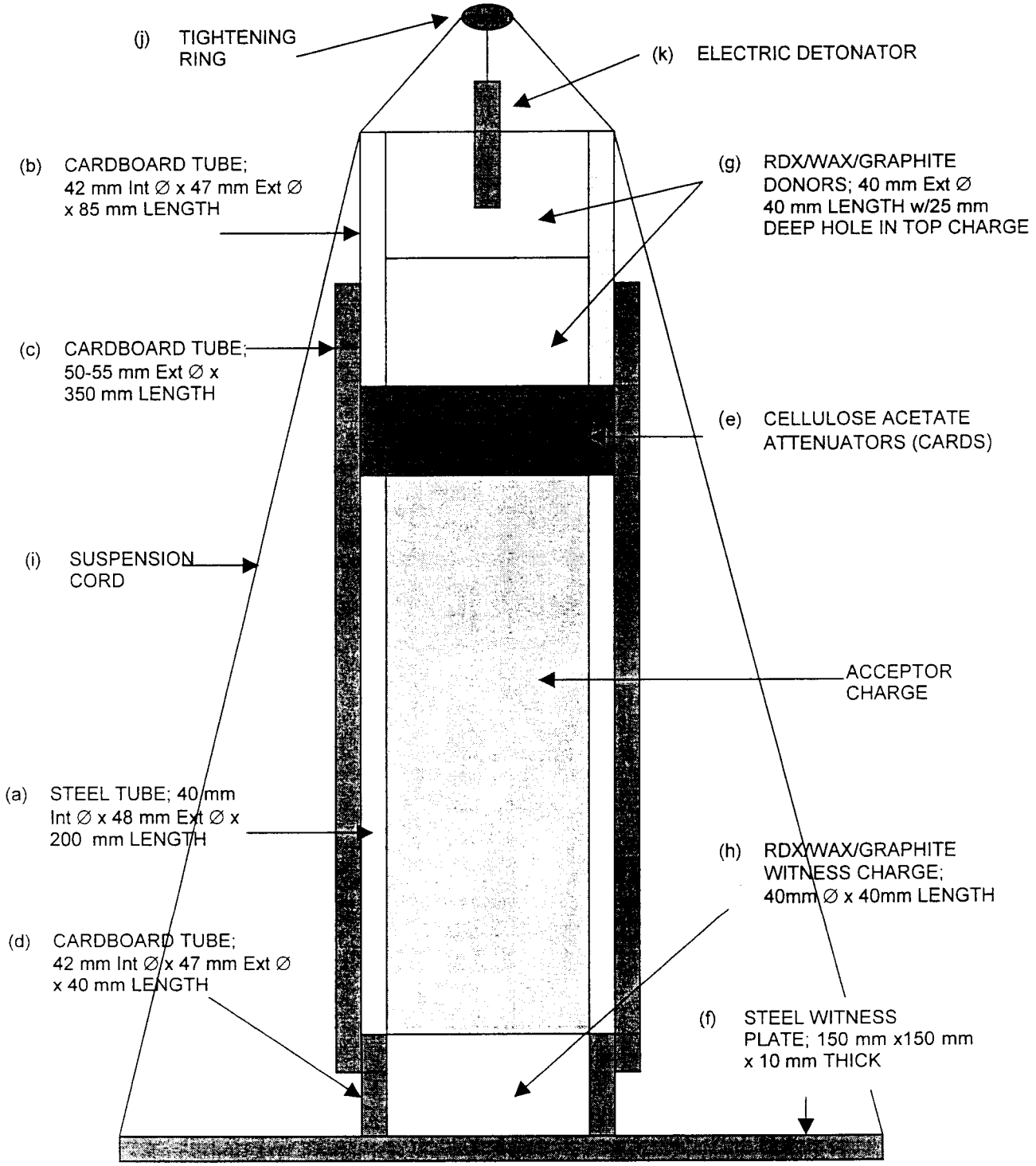


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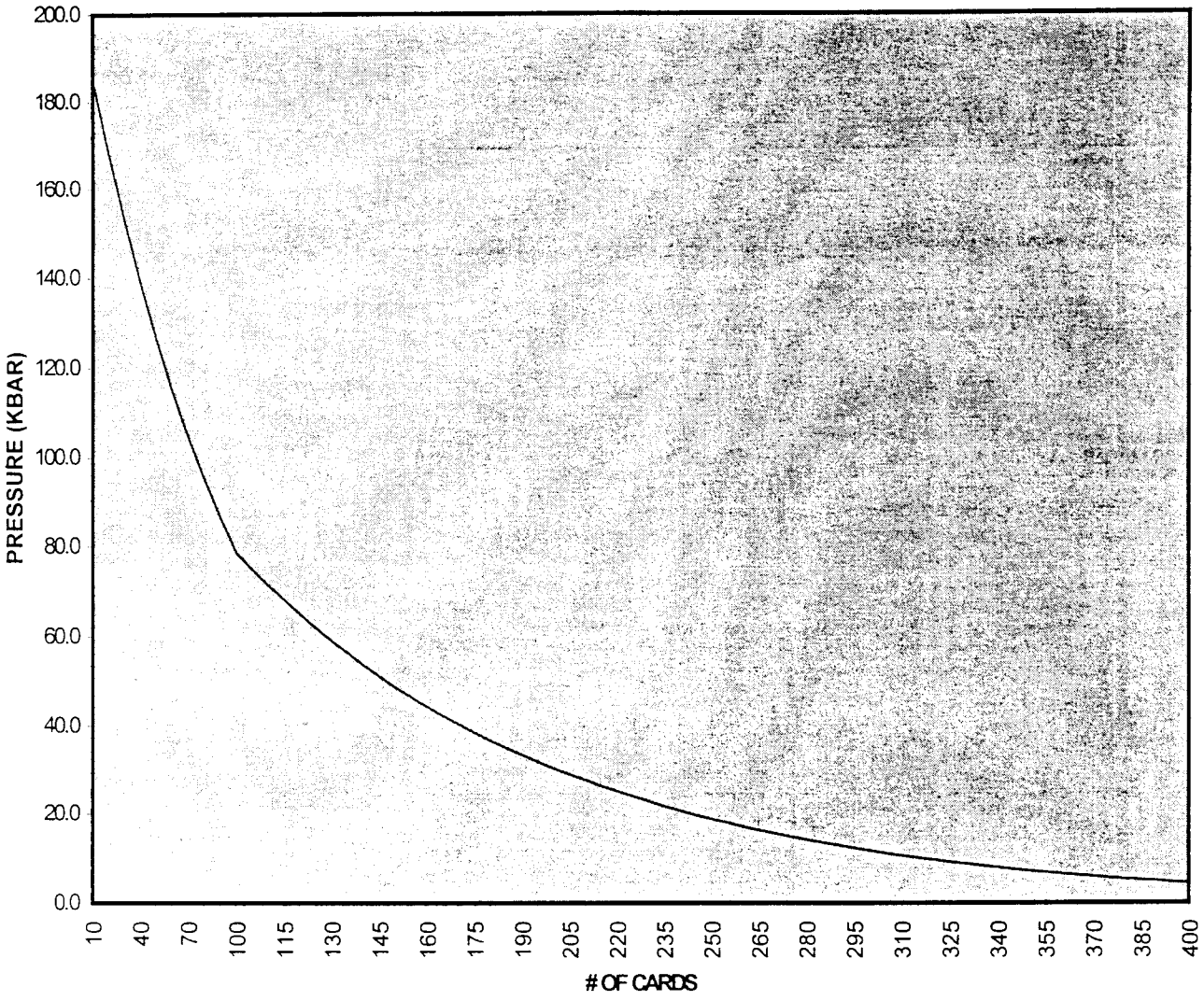
TABLE 2. INTERMEDIATE SCALE GAP TEST CALIBRATION DATA
(RDX/WAX/GRAPHITE DONOR)

# OF CARDS	BARRIER THICKNESS (mm)	PRESSURE (kbar)	# OF CARDS	BARRIER THICKNESS (mm)	PRESSURE (kbar)
10	1.90	185.4	230	43.70	22.8
20	3.80	168.6	235	44.65	21.7
30	5.70	153.2	240	45.60	20.7
40	7.60	139.3	245	46.55	19.7
50	9.50	126.7	250	47.50	18.8
60	11.40	115.1	255	48.45	18.0
70	13.30	104.7	260	49.40	17.1
80	15.20	95.2	265	50.35	16.3
90	17.10	86.5	270	51.30	15.6
100	19.00	78.7	275	52.25	14.8
105	19.95	75.0	280	53.20	14.1
110	20.90	71.5	285	54.15	13.5
115	21.85	68.2	290	55.10	12.9
120	22.80	65.0	295	56.05	12.3
125	23.75	62.0	300	57.00	11.7
130	24.70	59.1	305	57.95	11.1
135	25.65	56.4	310	58.90	10.6
140	26.60	53.7	315	59.85	10.1
145	27.55	51.2	320	60.80	9.7
150	28.50	48.8	325	61.75	9.2
155	29.45	46.6	330	62.70	8.8
160	30.40	44.4	335	63.65	8.4
165	31.35	42.3	340	64.60	8.0
170	32.30	40.4	345	65.55	7.6
175	33.25	38.5	350	66.50	7.2
180	34.20	36.7	355	67.45	6.9
185	35.15	35.0	360	68.40	6.6
190	36.10	33.4	365	69.35	6.3
195	37.05	31.8	370	70.30	6.0
200	38.00	30.3	375	71.25	5.7
205	38.95	28.9	380	72.20	5.4
210	39.90	27.6	385	73.15	5.2
215	40.85	26.3	390	74.10	5.0
220	41.80	25.1	395	75.05	4.7
225	42.75	23.9	400	76.00	4.5

TABLE 2. INTERMEDIATE SCALE GAP TEST CALIBRATION DATA (CONT) (RDX/WAX/GRAPHITE DONOR)



ANNEX C to
STANAG 4488
(Edition 1)

EXPANDED LARGE SCALE GAP TEST

Scope

1. This method covers the test procedures to be used for the determination of the expanded large scale shock sensitivity of explosive materials. This technique is primarily designed to be used for booster explosives, main charge explosives and propellants with critical diameters less than 76 mm.

2. Data from other similar scale tests are acceptable for Qualification as long as the test results are compared to a comparison explosive and a calibration curve of pressure in the barrier at the barrier/acceptor interface vs. attenuator thickness is available.

Principle

3. Like other gap tests, this test is a measure of the shock required to initiate and propagate a detonation in the explosive being tested. The sensitivity of the acceptor explosive is determined as a function of the thickness of a polymethylmethacrylate barrier which is used to attenuate the shock output of the donor explosive. Results are expressed as the thickness of the attenuator at which the acceptor is initiated 50% of the time. The corresponding pressure in the barrier at the barrier/acceptor interface may be obtained by referring to the appropriate calibration data provided in either Tables 3 or 4.

Apparatus

4. A schematic of the test setup for the Expanded Large Scale Gap test is shown in Figure 6. Acceptor explosives are either cast or pressed into a 4340 steel tube of 279 mm in length, 73.2 mm inner diameter, and 95.3 mm outer diameter. A tolerance of up to 10% for the inner and outer diameters is allowed to accommodate standard tube sizes available in Europe. The donor is comprised of two unconfined pellets containing either pentolite 50/50 or 95.0% RDX/5.0% Wax/0.5% Graphite with dimensions of each being 95.3 mm diameter and 47.6 mm thick. Attenuator sections are cut from a single block of 95.3 mm diameter PMMA.

5. An electric detonator, positioned with a plastic holder, is used to initiate the donor pellets. Witness plates of mild steel (304.8 mm x 304.8 mm x 19 mm thick), used to indicate whether detonation occurs, are placed below the acceptor with a 3.2 mm air gap separating the two.

Sample Preparation

6. The RDX/Wax/Graphite donor explosive pellets are pressed independently to a density of 1.60 $\pm$ 0.02 g/cm^3. Pentolite pellets are pressed to a density of 1.56 $\pm$ 0.01 g/cm^3. Test specimens are prepared by either casting the sample directly into the steel tube or by inserting a cylindrical sample into the tube. When preparing these samples, it is critical that the faces of the explosive sample be flush with the ends of the tube into which they are loaded. All sample explosives must be tested, by X-ray or other equivalent method, to ensure that there are no voids present.

Types of Reactions

7. Witness plate damage is used for interpretation of whether detonation has occurred. A positive result or "go" reaction is recorded when a neat hole is punched in the plate and an undamaged plate, broken plate, or one with a poor quality hole is considered a 'no go."

Test Procedure

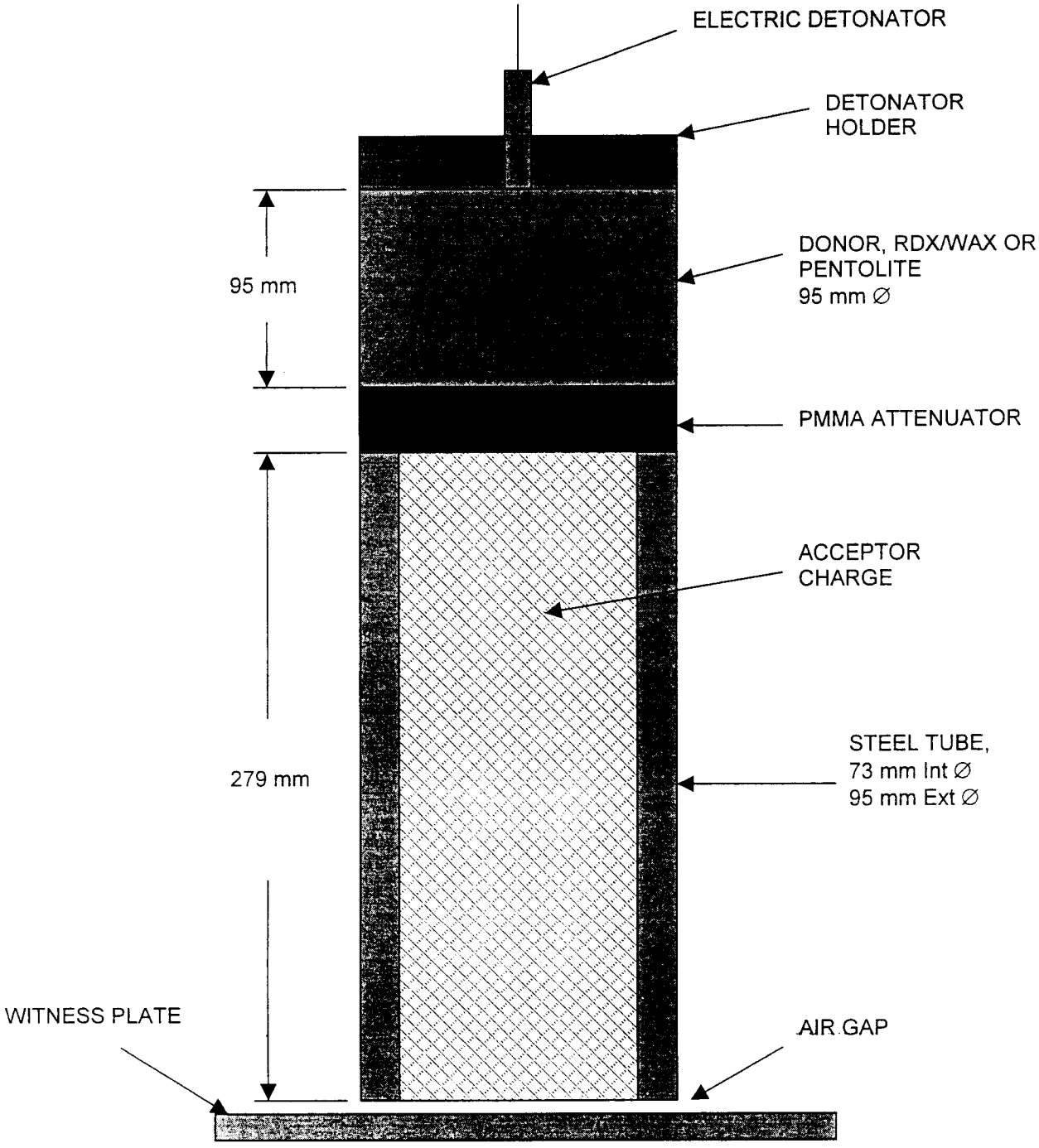
8. Twelve charges are usually required to establish a 50% gap thickness adequately. For an unknown material, the initial test is conducted with zero gap. If no detonation occurs, two additional tests are also performed at zero gap. If a detonation occurs, the next test is generally conducted at 12.7 mm gap thickness. Thereafter, the number of cards is doubled until a negative result "no go" is obtained. Subsequent tests are run by dividing in half the gap between the closest "go" and "no go" until one positive and one negative result, differing by one card, can be obtained.

9. A 50% point in mm of attenuator thickness is then determined for the test sample. A corresponding calibration table providing input pressure as a function of attenuator thickness is shown in Table 3 for the pentolite donor and Table 4 for the RDX/Wax donor.

Reporting of Results

10. Figure 4 of Annex A provides the standard data sheet under which all test information should be reported. For comparison purposes with other explosives and/or test methods, the final test result should be reported as the input pressure in kbar at which the 50% point is determined.

FIGURE 6. EXPANDED LARGE SCALE GAP TEST SETUP

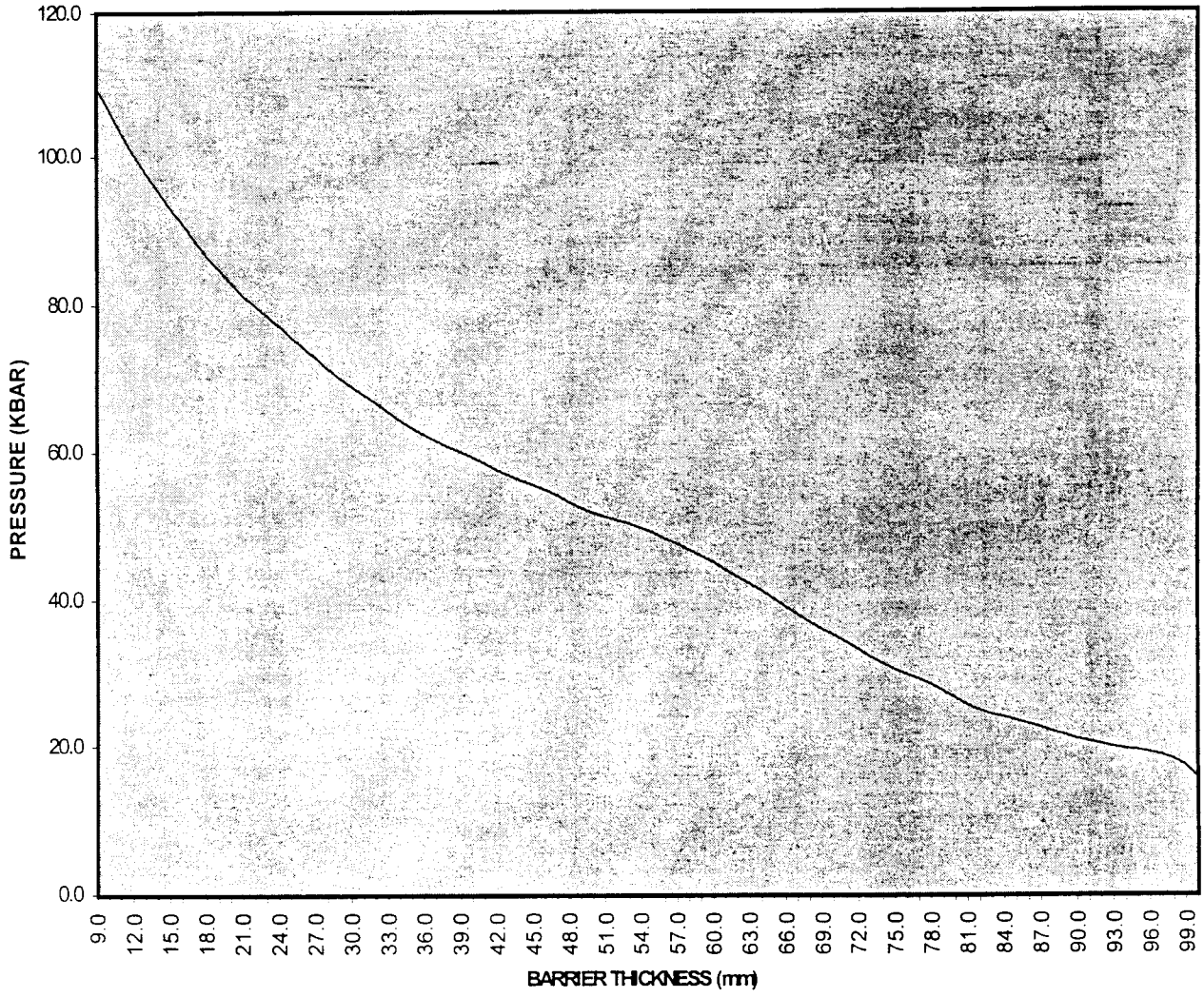


ANNEX C to
STANAG 4488
(Edition 1)

TABLE 3. EXPANDED LARGE SCALE GAP TEST CALIBRATION DATA
(PENTOLITE 50/50 DONOR)

ATTENUATOR THICKNESS (mm)	BARRIER PRESSURE (kbar)	ATTENUATOR THICKNESS (mm)	BARRIER PRESSURE (kbar)	ATTENUATOR THICKNESS (mm)	BARRIER PRESSURE (kbar)
9	109.6	40	59.4	71	34.3
10	106.7	41	58.6	72	33.4
11	103.5	42	57.7	73	32.3
12	100.6	43	56.9	74	31.3
13	97.9	44	56.2	75	30.5
14	95.5	45	55.6	76	29.8
15	93.1	46	54.9	77	29.2
16	91.0	47	54.2	78	28.5
17	88.8	48	53.3	79	27.6
18	86.7	49	52.5	80	26.6
19	84.8	50	51.8	81	25.7
20	83.1	51	51.3	82	25.0
21	81.4	52	50.8	83	24.4
22	80.0	53	50.3	84	24.0
23	78.6	54	49.8	85	23.6
24	77.2	55	47.6	86	23.1
25	75.8	56	46.8	87	22.6
26	74.4	57	46.0	88	22.0
27	73.0	58	45.1	89	21.5
28	71.6	59	44.1	90	21.0
29	70.3	60	43.1	91	20.6
30	69.1	61	42.2	92	20.2
31	67.9	62	43.1	93	19.9
32	66.8	63	42.2	94	19.6
33	65.7	64	41.3	95	19.4
34	64.5	65	40.2	96	19.1
35	63.4	66	39.1	97	18.8
36	62.5	67	38.0	98	18.2
37	61.6	68	37.0	99	17.3
38	60.8	69	36.1	100	15.7
39	60.1	70	35.3		

TABLE 3. EXPANDED LARGE SCALE GAP TEST CALIBRATION DATA (CONT)
(PENTOLITE DONOR)

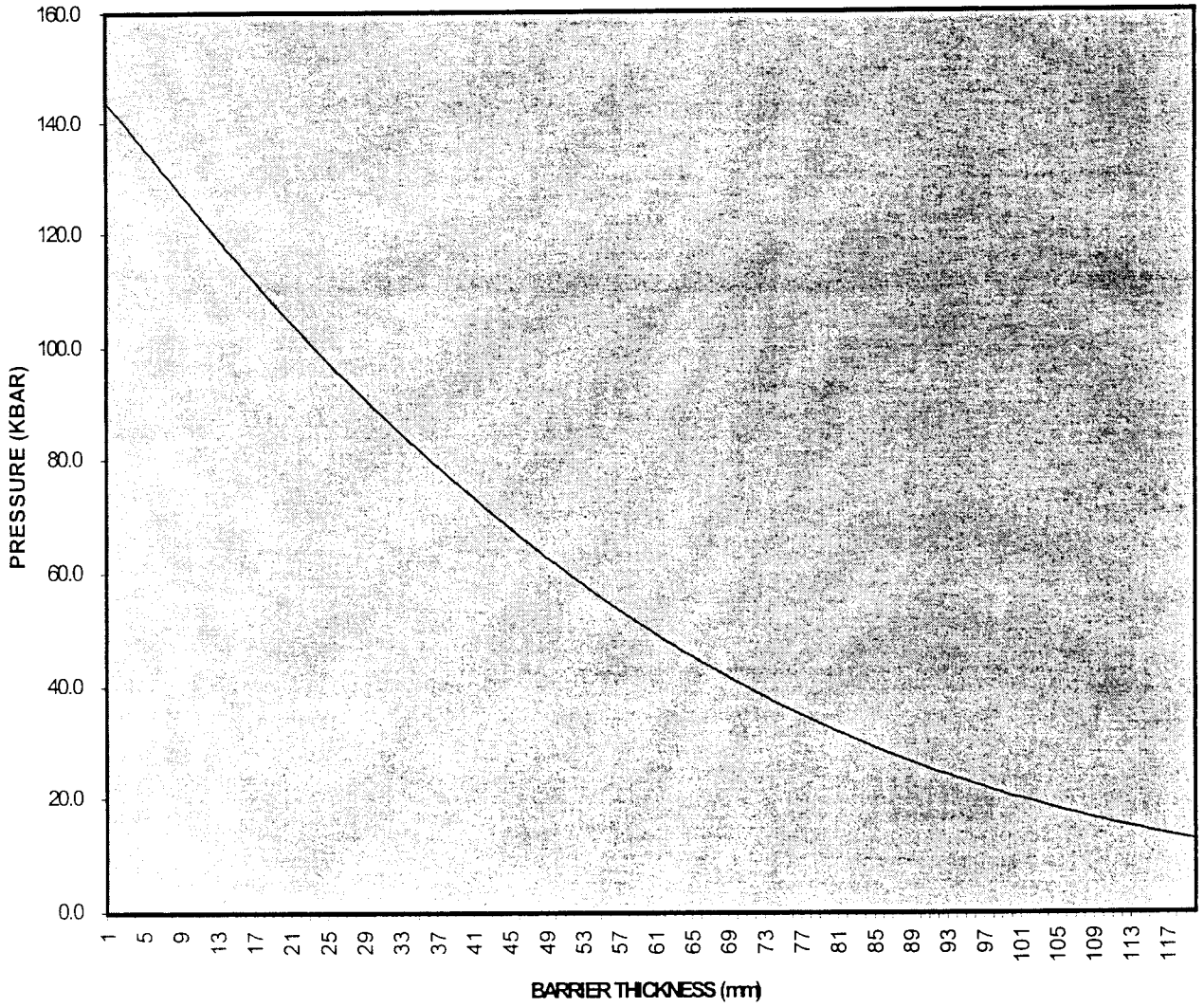


ANNEX C to
STANAG 4488
(Edition 1)

TABLE 4. EXPANDED LARGE SCALE GAP TEST CALIBRATION DATA
(RDX/WAX/GRAPHITE DONOR)

ATTENUATOR THICKNESS (mm)	BARRIER PRESSURE (kbar)	ATTENUATOR THICKNESS (mm)	BARRIER PRESSURE (kbar)	ATTENUATOR THICKNESS (mm)	BARRIER PRESSURE (kbar)
1	144.0	41	73.2	81	31.9
2	142.0	42	71.8	82	31.2
3	140.0	43	70.5	83	30.5
4	137.8	44	69.2	84	29.8
5	135.6	45	67.9	85	29.1
6	133.5	46	66.6	86	28.5
7	131.4	47	65.3	87	27.8
8	129.4	48	64.1	88	27.2
9	127.3	49	62.8	89	26.6
10	125.3	50	61.6	90	25.9
11	123.3	51	60.4	91	25.3
12	121.3	52	59.2	92	24.7
13	119.4	53	58.1	93	24.2
14	117.4	54	56.9	94	23.6
15	115.5	55	55.8	95	23.1
16	113.6	56	54.7	96	22.5
17	111.8	57	53.6	97	22.0
18	109.9	58	52.5	98	21.4
19	108.1	59	51.4	99	20.9
20	106.3	60	50.4	100	20.4
21	104.5	61	49.4	101	20.0
22	102.8	62	48.3	102	19.5
23	101.0	63	47.3	103	19.0
24	99.3	64	46.3	104	18.6
25	97.6	65	45.4	105	18.1
26	95.9	66	44.4	106	17.7
27	94.3	67	43.5	107	17.3
28	92.6	68	42.6	108	16.9
29	91.0	69	41.7	109	16.5
30	89.4	70	40.8	110	16.1
31	87.9	71	39.9	111	15.7
32	86.3	72	39.0	112	15.3
33	84.8	73	38.2	113	15.0
34	83.3	74	37.4	114	14.6
35	81.8	75	36.6	115	14.2
36	80.3	76	35.7	116	13.9
37	78.8	77	35.0	117	13.6
38	77.4	78	34.2	118	13.3
39	76.0	79	33.4	119	13.0
40	74.6	80	32.7	120	12.7

TABLE 4. EXPANDED LARGE SCALE GAP TEST CALIBRATION DATA (CONT)
(RDX/WAX/GRAPHITE DONOR)



ANNEX D to
STANAG 4488
(Edition 1)

SUPER LARGE SCALE GAP TEST

Scope

1. This method covers the test procedures to be used for the determination of the super large scale shock sensitivity of explosive materials. This technique is primarily designed only to be used for explosive materials with extremely large critical diameters (>76 mm). The test is a scaled version of the Expanded Large Scale Gap test described in Annex C.

Principle

2. Like other gap tests, this test is a measure of the shock required to initiate and propagate a detonation in the explosive being tested. The sensitivity of the acceptor explosive is determined as a function of the thickness of a polymethylmethacrylate barrier which is used to attenuate the shock output of the donor explosive. Results are expressed as the thickness of the attenuator at which the acceptor is initiated 50% of the time. The corresponding pressure in the barrier at the barrier/acceptor interface may be obtained by referring to the calibration data provided in Table 5.

Apparatus

3. A schematic of the test setup is shown in Figure 7. The donor charge is an unconfined 203 mm diameter by 203 mm length Composition B (60% RDX, 40% TNT) cylinder cast to a density of 1.68 $\pm$ 0.01 g/cm^3. This is initiated by an electric detonator and a Composition A-5 pellet. PMMA cards of 203 mm diameter are stacked to various thickness on the acceptor. Thickness of these cards ranges from 1.6 mm to 50.8 mm. The test explosive acceptor charge is cast into a 4340 steel case of 181.6 $\pm$ 2.5 mm inner diameter, 203 $\pm$ 2.5 mm outer diameter, and 406.4 $\pm$ 3.8 mm length.

4. A steel witness plate (182 cm x 91 cm x 5 cm) is placed beneath the acceptor and is used to verify whether a detonation has occurred.

Sample Preparation

5. Acceptor explosives are cast directly into the steel tube. The Composition B donor is cast independently and machined to the proper dimensions. When preparing these samples, it is critical that the faces of the explosive sample be flush with the ends of the tube into which they are loaded. All sample explosives must be tested, by X-ray or other equivalent method, to ensure that there are no voids present.

Types of Reaction

6. Witness plate damage is used for interpretation of whether detonation has occurred. A positive result or "go" reaction is recorded when a neat hole is punched in the plate and an undamaged plate, broken plate, or one with a poor quality hole is considered a "no go."

Test Procedure

7. Generally, eight to twelve charges are usually required to establish a 50% gap thickness adequately. For an unknown material, the initial test is conducted with zero gap. If no detonation occurs, two additional tests are also performed at zero gap. If a detonation occurs, the next test is conducted at a 50.8 mm gap thickness. Thereafter, the number of cards is doubled until a negative result or "no go" is obtained. Subsequent tests are run by dividing in half the gap between the closest "go" and "no go" until one positive and one negative result, differing by one card (1.6 mm), can be obtained.

8. A 50% point in mm of attenuator thickness is then determined for the test sample. A corresponding calibration table providing input pressure as a function of attenuator thickness is shown in Table 5.

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STANAG 4488
(Edition 1)

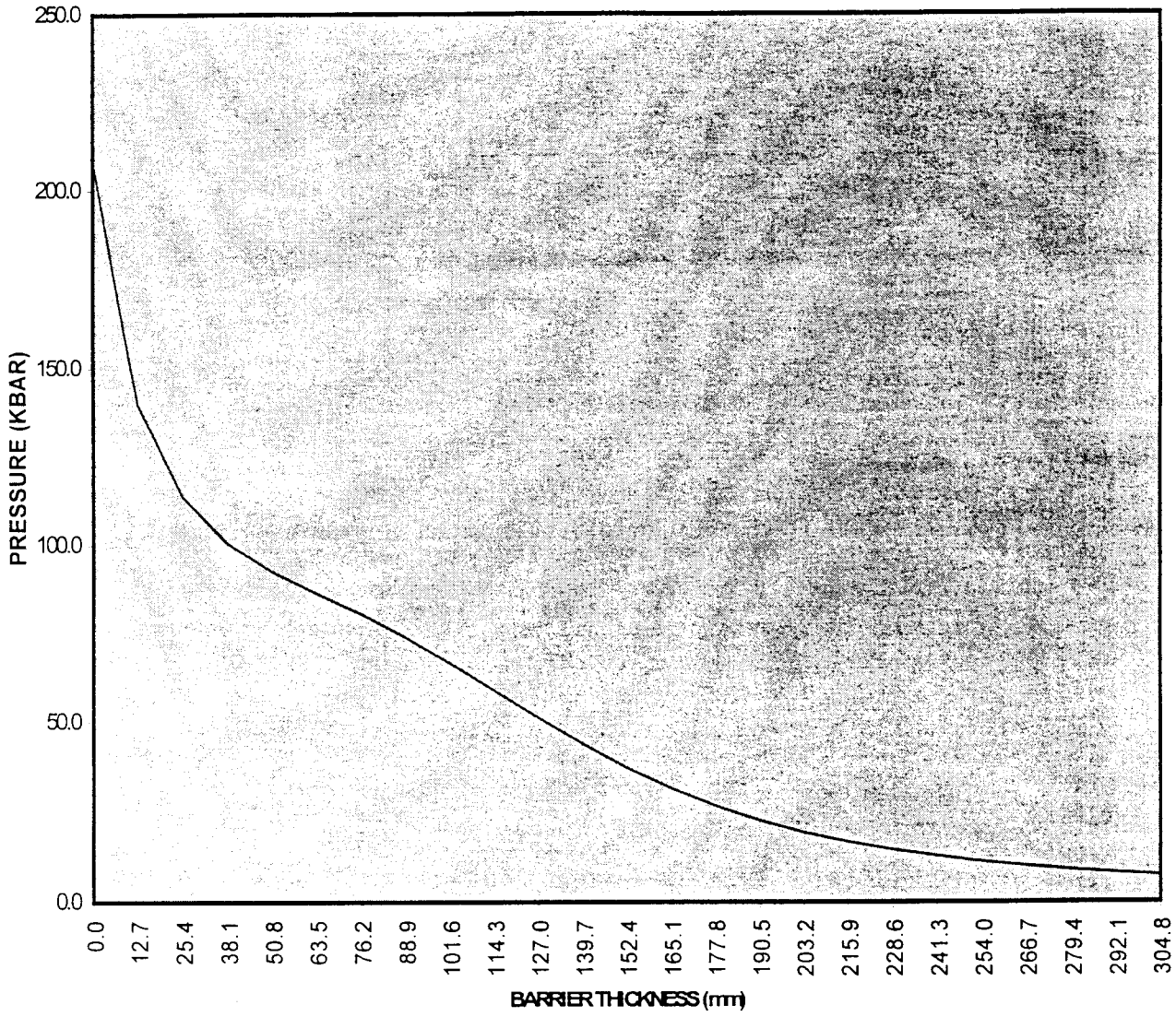
Reporting of Results

9. Figure 4 of Annex A provides the standard data sheet under which all test information should be reported. For comparison purposes with other explosives and/or test methods, the final test result should be reported as the input pressure in kbar at which the 50% point is determined.

TABLE 5. SUPER LARGE SCALE GAP TEST CALIBRATION DATA

ATTENUATOR THICKNESS (in.)	ATTENUATOR THICKNESS (mm)	INPUT PRESSURE (kbar)
0.0	0.0	208.6
0.5	12.7	139.6
1.0	25.4	113.6
1.5	38.1	100.6
2.0	50.8	92.7
2.5	63.5	86.6
3.0	76.2	80.7
3.5	88.9	74.2
4.0	101.6	66.8
4.5	114.3	59.0
5.0	127.0	51.2
5.5	139.7	43.8
6.0	152.4	37.2
6.5	165.1	31.5
7.0	177.8	26.7
7.5	190.5	22.7
8.0	203.2	19.4
8.5	215.9	16.8
9.0	228.6	14.6
9.5	241.3	12.8
10.0	254.0	11.3
10.5	266.7	10.1
11.0	279.4	9.0
11.5	292.1	8.2
12.0	304.8	7.5

TABLE 5. SUPER LARGE SCALE GAP TEST CALIBRATION DATA (CONT.)



RATIFICATION AND IMPLEMENTATION DETAILS

STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION	NATIONAL RATIFICATION REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION / MISE EN APPLICATION					
			INTENDED DATE OF IMPLEMENTATION/ DATE PREVUE POUR MISE EN APPLICATION			DATE IMPLEMENTATION WAS ACHIEVED/ DATE REELLE DE MISE EN APPLICATION		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE	ZST/OTAN of/du 13.11.01	Not implementing/Ne met pas en application						
CA	2441-4488 (A/DAPM 4-3) of/du 26.11.01	STANAG	01.02	01.02	01.02			
CZ	6/2-48/2001-1419 of/du 22.08.01	Czech Defence Standard No. 137601					09.01	09.01
DA	DS DA Ltr. FKO MAI2 0200171-003 of/du 26.03.02	STANAG	07.02	07.02	07.02			
FR								
GE								
GR								
HU								
IT								
LU								
NL	M 2002001552 of/du 16.04.02	STANAG				07.02	07.02	07.02
NO								
PL	134/ROK/P of/du 11.05.02	STANAG						
PO								
SP								
TU	TUDEL-02/STAN-1007	Not implementing/Ne met pas en application						
UK	D/Dstan/12/15/4488	STANAG						
US	Memo OUSD(A&T) of/du 11.06.02	MIL-STD-1751	06.02	06.02	06.02	06.02	06.02	06.02

* See reservations overleaf/voir réserves au verso

+See comments overleaf/Voir commentaires au verso

X Service(s) implementing/Armées mettant en application